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CERTIFICATE

This is to certify that this dissertation entitled **"A STUDY OF CLINICAL PROFILE OF HYPERGLYCEMIC SEIZURES"** is the bonafide record work done by **Dr. P. BALAMURUGAN,** submitted as partial fulfillment for the requirements of M.D. Degree Examinations, General Medicine (Branch I) to be held in March 2007.

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CONTENTS

INTRODUCTION

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Seizures associated with Non Ketotic Hyperglycemia is now more commonly recognised new entity among adults in our area.

HYPERGLYCEMIC SEIZURE – a special Neuroendocrine syndrome most commonly due to Non Ketotic Hyperglycemia has got its unique way of presentation, the clinical recognition of this entity was first made by MACCAIRO in 1965.[39]

The seizures may be the initial manifestation of Diabetes Mellitus. In the recent years clinical and experimental studies in animals, apart from routine investigations, CT Scan Brain, EEG and SPECT Scan were done to evaluate this entity. The clinical presentation of hyperglycemic seizures associated with Non Ketotic Hyperglycemia is studied only by few authors.

The real clinical picture needs further studies and evaluation and with this background, we evaluated clinical findings and investigations in all patients with hyperglycemic seizures.

AIM OF THE STUDY

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1. To study the clinical profile of Hyperglycemic Seizure (HGS).

2. To map out the age and sex incidence of Hyperglycemic Seizure (HGS).

3. To analyse the commonly occurring type of seizure in Hyperglycemic Seizure and to know the post seizure out come.

4. To evaluate the blood sugar levels with which Hyperglycemic Seizure occurs.

5. To decide the level of serum osmolalilty with which commonly Hyperglycemic Seizure occurs.

6. To know the associated CNS / Systemic problems.

7. To determine the best line and outcome of management.

REVIEW OF LITERATURE

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The occurrence of seizures as a presenting feature of Hyperglycemia was first reported by Maccario et al in 1965. But its clinical recognition at present is common among neurologists and uncommon among General Practitioners.

The metabolic causes of seizure in patients in particular diabetes mellitus with Non ketotic hyperglycemia (NKH) and its association with focal seizures were recognized only in the last decade both in India and around the world.

There is more than five papers in India including Paediatric population and greater than 30 papers have been published throughout the world including English and other languages (Data details collected through Internet).

Definition of diabetes mellitus (Joslin)[1]

Diabetes mellitus is a syndrome, characterized by chronic hyperglycemia with disturbances of carbohydrate, fat and protein metabolism resulting from defects in insulin secretion, insulin action or both.

When fully expressed, diabetes is characterized by fasting hyperglycemia, but the disease can also be recognized during less overt stages and before fasting hyperglycemia appears, most usually by the presence of glucose intolerance.

Diabetes Mellitus may be suspected or recognised clinically by the presence of characteristic symptoms such as excessive thirst, polyuria, polyphagia otherwise unexplained weight loss, and in its most severe forms, with ketoacidosis or non ketotic Hyperosmolality of which, in the absence of effective treatment, leads to stupor, coma and death.

RISING GLOBAL BURDEN OF DIABETES[1,6]

Diabetes is one of the most common Non Communicable disease occurring globally.

In 1997 an estimated 123 million people have diabetes globally, or about 2.1% of world population.

By the year 2010, the total number of people with diabetes projected to reach 221 million world wide.

Globally, there are more women with Diabetes than men. Recent studies put the numbers 62 million, at 73 million versus respectively.

Asia is likely to have 61% of the total globally projected number of people with Diabetes by 2010.

Newer Etiological classification of diabetes mellitus[4,6]

(Adapted from American Diabetes Association, 2004)

I. Type 1 diabetes (β-cell destruction, usually to absolute insulin deficiency)

a. Immune-mediated.

b. Idiopathic

II. Type 2 diabetes (may range from predominantly insulin resistance with relative insulin deficiency to a predominantly insulin secretory defect with insulin resistance)

III. Other specific types of diabetes

a. Genetic defects of β-cell function characterized by mutations in:

i. Hepatocyte nuclear transcription factor (HNF) 4α (MODY 1)

ii. Glucokinase (MODY 2)

iii. HNF-1 α (MODY 3)

iv. Insulin promoter factor (IPF) 1 (MODY 4)

v. HNF-1 β (MODY 5)

vi. NeuruoD1 (MOD V 6)

vii. Mitochondrial DNA

viii. Proinsulin or insulin conversion.

b. Genetic defects in insulin action

i. Type A insulin resistance
ii. Leprechaunism
iii. Rabson-Mendenhall syndrome
iv. Lipodystrophy syndromes

c. Diseases of the exocrine pancreas – pancreatitis, pancreatectomy, neoplasia, cystic fibrosis, hemochromatosis, fibrocalculous pancreatopathy.

d. Endocrinopathies – acromegaly, Cushing's syndrome, glucagonoma, pheochromocytoma, hyperthyroidism somatostatinoma, aldosteronoma.

e. Drug – or chemical-induced – Vacor, pentamidine, nicotinic acid, glucocorticoids, thyroid hormone, diazoxide, β-adrenergic agonists, thiazides, phenytoin, α-interferon, protease inhibitors, clozapine, beta blockers.

f. Infections – congenital rubella, cytomegalovirus, coxsackie.

g. Uncommon forms of, immune-mediated diabetes – "stiff-man" syndrome, anti-insulin, receptor antibodies.

h. Other genetic syndromes sometimes associated with diabetes – Down's syndrome, Klinefelter's syndrome. Turner's syndrome, Wolfram's syndromes, /friedreich's ataxia, Huntington's chorea. Laurence-Moon=biedl

syndrome, myotonic dystrophy, porphyia, Prader-Willi syndrome.

IV. Gestational diabetes mellitus (GDM).

New diagnostic criteria for diabetes mellitus[1,4,6]

1. Symptoms of Diabetes plus casual Plasma glucose concentration > 200 mg / dl (11.1 mmol/L). Casual Glucose is defined as plasma glucose levels at any time of day without regard to time since last meal.
2. FPG > = 126 mg/dl (7.0 mmol/L). Fasting is defined as no caloric intake for atleast 8 hours.
3. 2 hour PG > = 200 mg/dl (11.1 mmol/L) during an OGTT. The test should be performed as described by WHO, using a glucose load containing the equivalent of 75 gm anhydrous glucose dissolved in water. The third measure [OGTT] is not recommended for routine clinical use.

Criteria:

When any one of the above 3 criteria's are positive it has to be confirmed on any subsequent day to any one of the above 3 tests.

Epilepsy:[3]

Lord Russell Brain gave a more detailed definition. According to him, an epileptic seizure is defined as an "intermittent stereotyped

disturbance of consciousness, behavior, emotion, motor function or sensation that on clinical grounds is believed to result from cortical neuronal discharge".

Nature of discharging lesion[3,12,13]

Seizure discharge can be initiated in an entirely normal cerebral cortex, as happens when the cortex is activated by administration of drugs; withdrawal of alcohol or other sedative or by repeated stimulation by sub-convulsive pulses (kindling phenomenon). The electrical properties of a cortical epileptogenic focus suggest that its neurons have an increased ionic permeability that renders them suspeceptible to activation by hypothermia, hypoxia, hypoglycemia, hypocalcaemia and hyponatermia, repeated sensory stimulation and during some phases of sleep. Epileptic foci are characterized by spontaneous inter-ictal discharges during which neurons of the discharging focus exhibit large calcium mediated PDS followed by prolonged, after Hyper Polarisation (AHP). The AHP are due to Calcium dependent K^+ currents, better explained by enhanced synaptic inhibition. The PDS summate to produce surface recorded inter-ictal EEG spikes. The AHP correspond to show wave of EEG spike and wave complex.

The neurons surrounding the epileptogenic focus are hyper polarized from the beginning and are GABA ergic inhibitory neurons

within the focus. Seizure spread depends on any factor or agent that activates the neurons within the focus or inhibits the surroundings neurons.

The level of extra cellular Potassium is elevated in glial scars near epileptic foci and a defect in voltage sensitive Calcium channels has been postulated. Deficiency of neuro-transmitter GABA, increased Glycine, decreased taurine, decreased and increased glutamic acid etc. have been reported in human epileptogenic tissue.

Firing of epileptogenic neurons in cortical focus is reflected in EEG as a series of spike wave discharges that increase progressively in amplitude and frequency. Once the intensity of seizure discharge exceeds a certain limit it overcomes the inhibitory influences of the surrounding neurons and spreads to neighbouring cortical and subcortical synaptic connections.

If unchecked the cortical spreads to the adjacent cortex and the contra lateral cortex via the inter-hemisphere pathways. The first clinical manifestations depend on the part of the brain from which the seizure originates. There is propagation to sub-cortical nuclei and spinal neurons via the corticospinal and reticulospinal pathways. The spread of excitation to the sub-cortical and brainstem centers corresponds to the tonic phase of the seizure, loss of consciousness and signs of autonomic

over activity. Soon after the spread of inhibition a diencephalo-cortical inhibition beings and intermittently interrupts the seizure discharge, changing it from tonic to clonic phase.

The intermittent clonic burst becomes less and less frequent and eventually ceases completely leaving in their awake exhausted neurons in the epileptogenic focus and increased permeability of the blood brain barrier. These changes form the basis of Todd's post-epileptic paralysis. There is 2 – 3 fold increase in the glucose utilization of neurons during seizure discharge and the paralysis could be due to neuronal depletion of glucose and accumulation of lactate.

The spike and wave complex which represents brief excitation followed by slow wave inhibition is the type of pattern that characterizes the clonic (inhibitory) phase of focal motor or Grandmal seizures. Temporal lobe seizures arise in the medial temporal lobe, amygdaloid nuclei and hippocampus. They may also arise in the convexity of the temporal lobe. Loss of memory for events of the episode is due to the paralytic effect of the neuronal discharge in the hippocampus. The seizure focus may establish a persistent secondary focus in the corresponding control area of the opposite hemisphere via cortical connection called mirror focus. The mirror form is the source of confusion in trying to identify the side of the primary lesion by EEG.

Severe seizures may cause systemic lactic acidosis with fall in arterial pH, reduction in arterial O_2 saturation and rise in PCO_2 which are secondary to respiratory spasm and excessive muscular activity. Heart rate, blood pressure and CSF pressure rise during seizure.

The rise in BP evoked by seizure causes significant increase in cerebral blood flow to meet the increased metabolic needs of the brain.

In 1929, Dr. HarisBergers reported that interictal EEG changes were common in Epilepsy.

Classification of seizure and Epilepsy syndrome[7,9]

An epilepsy syndrome is a composite of signs and symptoms associated with certain pathology or etiology (idiopathic) many of the idiopathic syndromes are inherited. Syndromic classification is useful because some of the syndromes have well defined prognosis.

An International League Against Epilepsy [ILAE] to develop in 1981 a classification of Epileptic seizure. The classification makes use of both clinical and EEG information. Classification of different epileptic syndromes based on seizure types occurring within the syndrome; age of onset and etiology will be of vital importance in the management of patients with epilepsy. The classification of seizures is constantly being modified. In the latest version (Epilepsia 30: 389, 1989); an attempt has been made to incorporate all of the epilepsies, epileptic syndrome and related seizure disorders and to categories them not only as partial or generalized; but also according to the age of onset,

primary or secondary nature of the seizure and the many clinical settings in which they occur. (Adapted from commission on the terminology and classification of International League Against Epilepsy. Epilepsia: 26, 268-275/1985).

International classification of epileptic seizures

Partial (Focal, Local) seizures

Simple partial seizure (without impairment of consciousness)

With motor signs

With sensory symptoms

With autonomic symptoms or signs

With psychic symptoms

Complex partial seizures (with impairment of consciousness)

Simple partial onset followed by impairment of consciousness

With simple partial features followed by impaired consciousness

With automatisms

With impairment of consciousness at onset

With impairment of consciousness only

With automatisms

Partial seizures evolving to secondary generalized seizures

Simple partial seizures evolving to generalized seizures

Complex partial seizures evolving to generalized seizures

Simple partial seizures evolving to complex partial seizures evolving to generalized seizures

Generalized seizures

Absence seizures

Absences

Atypical absences

Myoclonic seizures

Tonic seizures

Atonic seizures

Clonic seizures

Tonic-clonic seizures

International classification of epilepsies and epileptic syndromes

Focal epilepsies / epileptic syndromes:

Idiopathic:

Benign childhood epilepsy with centrotemporal spikes

Childhood epilepsy with occipital paroxysms

Primary reading epilepsy

Symptomatic

Chronic progressive epilepsia partialis continua of childhood

Epilepsy characterized by seizures with specific modes of precipitation

Cryptogenic

The symptomatic and cryptogenic categories comprise syndrome of great individual variability that are based mainly on:

Seizure types (according to International Classification of Epileptic Seizures)

Anatomic localization:

Temporal lobe epilepsies

Frontal lobe epilepsies

Parietal lobe epilepsies

Occipital lobe epilepsies

Bi-and multilobar epilepsies

Etiology (for symptomatic epilepsies)

Specific modes of precipitation

Generalized Epilepsies / Epileptic syndromes

Idiopathic:

Benign familial neonatal convulsions

Benign neonatal convulsions

Benign myoclonic epilepsies of infancy

Childhood absence epilepsy (pyknolepsy)

Juvenile absence epilepsy

Juvenile myoclonic epilepsy

Epilepsy with grand mal (GTC) seizures on awaking

Other idiopathic generalized epilepsies not defined above

Epilepsy with seizures precipitated by specific modes of activation

Cryptogenic

West syndrome

Lennox-Gastaut syndrome

Epilepsy with myoclonic-astatic seizures

Epilepsy with myoclonic absences

Symptomatic

Non-specific etiology

Early myoclonic encephalopathy

Early infantile encephalopathy with suppression bursts

Others symptomatic generalized epilepsies not defined above

Specific syndrome

Neonate

Non-ketotic hyperglycemia

D-glyceridacidemia

Seizure precipitants [9]

Seizure precipitants are those circumstances that precede the onset of on epileptic attack and are considered by both patient and

neurologist to be possible explanation for why the seizure happened when it did and not earlier (or) later.

Seizure precipitating (or) triggering factors involve chemical or physiologic stimulation capable of precipitating factors.

Common seizures precipitants:

1. Sleep deprivation
2. Sudden awakening
3. Fatigue and exercise
4. Alcohol
5. Missed antiepileptic medication
6. Drugs lowering seizure threshold
7. Hyperventilation
8. Metabolic factors like Hypenatremia (or) hyponatermia, Hypocalcemia, Hypoglycemia.
9. Fever.

Triggered seizures

Seizure may be triggered by specific stimuli.

1. Visual stimuli
2. Auditory stimuli
3. Somatosensory stimuli
4. Complex stimuli

5. Self induced seizure.

Modulators of seizure occurrence

1. Sleep
2. Hormones of catamenial epilepsy
3. Emotional situations.

CLINICAL FEATURES

The clinical symptoms and signs of partial seizures (simple and complex) are discussed here.

Simple Partial Seizures: [9, 14]

Any part of the body may be involved in a focal seizure depending on the site of epileptic discharge in the motor cortex. It may be in the form of jacksonian march, speech arrest or partial dysphasia or epileptic pallilalia. Todd's paralysis may follow a focal seizure and lasts for minutes to hours.

Partial seizures with autonomic symptoms:

Rarely partial seizures may manifest by autonomic disturbance such as vomiting, pallor, flushing, sweating and pupillary dilatation.

Partial seizures with somatosensory or special sensory symptoms:[14,12]

These arise from the sensory cortex and may march in a manner akin to motor seizures. Special sensory seizures consist of auditory, gustatory, olfactory (uncinate seizures) and visual phenomena.

Vertiginous hallucinations like intense feeling of dizziness can sometimes occur.

Complex partial seizures: [15, 17, 18]

The most common type of complex partial seizures, occurring in over 90% of patients, is that with psychomotor symptomatology. In about half of the patients the seizure is preceded by an aura. Then a phase of motionless total unresponsiveness begins lasting for about 10-15 seconds. Facial grimace and head turning often precede this phase. The head turning has no localizing value.

The second phase is longer lasting 20-30 second and consists of stereotyped automatic motor activity or "automatisms". The most common automatisms involve the face and lips. Chewing movements are called de novo automatisms and can arise from either internal or external stimuli. Each of these subjective psychic experiences may constitute the entire seizure or combinations may occur and proceed to a period of unresponsiveness. The motor components of the seizures occur during the later phase and take the form of automatisms. These include lip smacking, Chewing or swallowing movements, fumbling of the hands or shuffling of the feet. Certain complex acts that were initiated before the alteration of consciousness such as walking, chewing

food, turning the pages of a book or even driving may continue. However if asked a specific question or given a command, the patient is obviously out of contact. There may be no response at all or the patient may look towards the examiner in a perplexed way or utter a few stereotyped words. The patient is thus confused and in an irritable state, may resist or strike out at the examiner.

The violence and aggression that are said to characterize patients with temporal lobe epilepsy take this form of non-directed oppositional resistance in response to restraint during the period of automatic behavior (called so, because the patient presumably acts like automation). Unprovoked assaults or outbursts of intense rage or blind fury are unusual. Rarely laughter or roaming may be the most striking feature of an automatism (Gelastic epilepsy and Epilepsia procursiva respectively); or simply wander aimlessly either as an ictal or postical phenomenon (Poriomania). Dystonic posturing of the arm and leg contra lateral to the seizure focus is found to be a frequent accompaniment. After the attack, the patient usually has no memory about what was said or done. Any type of CPS may proceed to tonic spasm or other forms of secondary generalized seizures.

Seizures of temporal lobe origin can be at times confused with a number of psychiatric conditions like hypomania or schizophrenia. Some patients will lapse into paranoid, delusional or amnesic psychosis for a few days or weeks. EEG during this period may show no seizure activity in the Amygdala and other deep temporal lobe structures.

Psychiatrists make the diagnosis of temporal lobe epilepsy rather fairly. Helpful in diagnosis is the known occurrence of seizures, amnesia for some of the events of the psychosis and seizure discharges in EEG. MRI will disclose a temporal lobe lesion CPS in about a third of cases. Postictal posturing and paresis of an arm or aphasia helpful in detecting the side of lesion.

The third or last phase in CPS is the phase of partial responsiveness with reactive automatism. This phase can last for up to 5 minutes, the patient being confused usually for two to three minutes with an individual patient tending to have seizures of the same duration on each occasion.

Other types of CPS with psychomotor symptomatology include the seizures of “temporal lobe syncope” and “frontal lobe epilepsy”. Both these seizures have been recognized as specific sub types only after the introduction of video recording and EEF telemetry. The seizure of temporal lobe syncope being with loss of tone, which may involve the muscles of the head nodding or may fall to the floor. He or she is then unresponsive and confused. Responsiveness is regained slowly, the patient exhibiting reactive automatism of about two minutes before full recovery. The seizures are generally refractory to medical therapy and are dangerous because sudden falls lead to frequent injury.

The seizures of frontal lobe epilepsy are noted for being ‘motor’ and less ‘psychic’ than those arising from the temporal lobe area. A fall

may herald the onset of a seizure followed by vigorous stererotyped automatisms consisting of bilateral leg extension, kicking and thrusting about and aggressive sexual automatisms. The attacks appear bizarre and very often misdiagnosed as ‘hysterical’. Occipital lobe CPS is suspected by the initial ictal event. Simple visual hallucination, eye deviation or ictal blindness suggest occipital lobe origin.

Inhibitory factors particularly of the cortex and the thalamus usually terminate focally originating motor seizures after one to two minutes. In other circumstances, excitation overwhelms inhibition, allowing extensive propagation and secondary generalization. When neither side wins this ‘excitatory-inhibitory struggle’, a prolonged or re-iterative partial motor seizure results. Several varieties have been described.

The first variety described by Kojevnikov and termed Epilepsia partialis continua, consists of repeated Jacksonian seizures characterized by a motor march. Between such attacks, persistent stereotyped, focal myoclonic episodes occur, involving the area from which the ‘march’ originates. This may be the most common type occupying a midpoint between the following extremes.

The second variety consists of persistent, stereotyped, focal or regional, periodic or quasi-periodic myoclonus without ‘march’. At the other extreme are repetitive attacks or Jacksonian march.

Historically, debate has centered on whether such phenomena represent Rolandic cortical discharge or sub-cortical disturbance. The close and sustained relationship between the cortex and thalamic nuclei in epileptiform events suggests the involvement of both strctures.

Studies by Chastrian et al and Thomas et al indicate that epilepsia partialis continua and its variants usually represent a regional lesion involving the cortex, sometimes in the setting of an anoxic, metabolic or septic encephalopathy. The focal lesion may result from stroke, trauma, metastasis or primary tumor; it is usually of recent onset. An old lesion is less commonly associated with epilepsia partialis continua unless the patient develops a diffuse encephalopathy.

Complex partial status:

In this variety, continuous altered behavior has been observed. Complex partial status epilepticus may constist of alternating phases of total unresponsiveness and speech arrest with stereotyped automatisms and partial responsiveness, with partial speech arrest and quasi-purposive automatisms. At times, a Complex partial status may result in wandering, a condition termed “fugue state”. Seizures may be confused with psychiatric disease or metabolic or other encephalopathies with delirium, i.e., Delirum tremens. A sudden alteration of behaviour

particularly in patients with a previous history of epilepsy should raise this possibility. The usual site of origin is mesial temporal and the limbic structures or the frontal areas. There may also be autonomic disturbances such as pupillary dilatation or even fever.

Epilepsia partialis continua [9,16,29]

Epilepsia partialis continua is a form of simple partial status epilepticus, usually arising from a focus in the prefrontal motor cortex. It is "a spontaneous regular or irregular clonic muscles twistings of cerebral cortical origin, sometimes aggravated by sensory stimuli continued to one part of the body and continuing for hours, days or week".

Upto (50%) 38 of cases particularly in children, one caused by Rasmeussen's encephalitis, chronic inflammatory process of unknown etiology affecting one hemisphere and presenting with a progressive hemiplegia, seizure including Epilepsia partialis continua and sometimes cognitive decline.

Common causes of seizures of new onset, [9]

A. Primary neurological disorders.

i. Benign febrile convulsions of childhood.

ii. Idiopathic epilepsy

iii. Head trauma

iv. Stroke of vascular malformation

v. Mass lesions

vi. Meningitis or encephalitis

vii. Rett's syndrome and autism

viii. Alzheimers disease

ix. Huntington's disease.

B. Systemic disorders

i. Hypoglycemia

ii. Hyponatremia

iii. Hyperosmolar states like hyperosmolar non ketotic coma.

iv. Hypocalcemia

v. Uremia

vi. Hepatic encephalopathy

vii. Porphyria

viii. Drug overdose

ix. Drug withdrawal

x. Global cerebral ischemia

xi. Hypertensive encephalopathy

xii. Eclampsia

xiii. Hyperthermia

Other causes related to the type of epilepsy

Generalized seizures

1. Primary (Idiopathic): Genetic, family history may be present

2. Diffuse cerebral insults.

a. Encephalitis

b. Anoxia

c. Storage disorders

3. Metabolic disorders [35]

a. Hypocalcemia

b. Hyponatremia

c. Hypoglycemia

d. Porphyria

e. Renal failure

f. Hepatic failure

g. Hyperglycemia

4. Drugs and toxins [36]

a. Abstinence (benzodiabepins, barbiturates)

b. Alcohol

c. Antidepressants

d. Phenothiazines

e. Amphetamines

f. Local anaesthetics

g. Metronidazole

h. Drug and alcohol withdrawal

i. Imipramine

Partial seizures

1. Cerebral trauma
    a. Birth injury
    b. Head injury-cerebral contusion and hemorrhage
2. Structural lesions
    a. Vascular Malformation
    b. Aneurysms
    c. Cerebral tumors
    d. Cysts
    e. Hydrocephalus
3. **Infections**
    a. Meningitis
    b. Encephalitis
    c. Abscess
    d. Empyema
    e. Syphilis
    f. Neurocysticercosis
    g. Tuberculosis
    h. HIV
    i. Toxoplasmosis
4. **Inflammation**

a. Sarcoidosis

b. Multiple sclerosis

c. Systemic lupus erythematoses

5. **Metabolic and systemic disorders:** [45,47,49,50]

Metabolic and systemic disorders may be associated with seizures that abate with correction of the underlying abnormality. These patients are not considered to have epilepsy.

a. Hypoglycemia: can produce seizures especially when serum glucose levels fall to 20-30mg%. In about 6% of patients, focal motor seizure is the initial symptoms of the disorder.

b. Hyponatremia: may be associated with seizures at serum sodium levels below 120 meq/l or at a higher level following a rapid decline.

c. Hyperosmolar states: including both hyperosmolar non ketotic hyperglycemia and hypernatremia may lead to seizures when the plasma osmolality rises above 330 mosm/l

d. Hypocalcemia: with serum calcium levels in the range of 4.3 – 9.2 mg/dl can produce seizures with or without tetany.

e. **Uremia:** can cause seizures especially when it develops rapidly. Seizures are reported during dialysis (dialysis dysequilibrium) related to the levels of Aluminium used in the dialysate.

f. **Heptatic encephalopathy:** is sometimes associated with generalized or focal seizures.

g. **Porphyria :** is a disorder of Heme biosynthesis that produces both neuropathy and seizures. Bromides are used for treatment as most anticonvulsants can exacerbate the disorder and hence seizures. Seizures are seen in 15% of patients with AIP.

h. **Drug overdosage:** can exacerbrate epilepsy or can cause seizures in non-epieptics.

i. **Drug withdrawal:** especially withdrawal from ethanol, sedatives or anticonvulsants may be accompanied by one or more GTCS that usually occur within 48 hours.

j. **Global cerebral ischemia:** may be associated with spontaneous myoclonus, action myoclonus, and partial or generalized seizures.

k. **Hypertensive encephalopathy:** can present with GTCS or partial seizures.

l. **Eclampsia:** is diagnosed when a woman who has the clinical traid of pre-eclampsia (Systemic hypertension, proteinuria and edma) develops seizures or coma. Eclampsia usually occurs in the

third trimester, near term, but can occur upto 2 weeks post partum period.

m. **Cerebral Venous Thrombosis (CVT):** Eclampsia and CVT are two conditions prominently associated with seizures during and just after pregnancy. In India 50% of all strokes in women are related to pregnancy and puerperium and 90% of these are due to sinovenous infarction.

Clinical features include raised ICT, altered sensorium, seizures, focal neurological deficits and crainial nerve palsies. Diagnosis can be established by CT / MRI / Angiography. The most frequent direct sign in CT scan is the 'empty delta sign' (triangular rim of contrast surrounding a clot within the superior sagittal sinuses) which is seen in 30% of cases. Treatment includes control of infection, cerebral edema and other supportive measures. Heparinisation has been found to be useful in improving the outcome in recent studies.

n. **Hyperthermia:** can result from infection, heat stroke, hypothalamic lesions and drugs like phencyclindine, anticholinergics, neuroleptics, anaesthetic agents and neuromuscular blockers. Clinical features include seizures, confusion or coma, shock and renal failure.

o. **Hypomagnesemia:** Serum Magnesium levels less than 1.3m 01/1 can cause seizures.

p. **Hypophosphatemia:** Tonic clonic seizures occur with serum phosphate levels less than 1 mg/dl.

q. **Thyroid disease:** Seizures occasionally occur in hyperthyroidism. Seizures are more common with hypothyroidism and may occur in about 25% of patients with myxoedema coma.

Imaging modalities used in diagnosis [19,20]

At present the two most widely used imaging modalities in neuro-radiology are CT scan and MRI. CT is well suited for imaging of the bone, calcifications and hemorrhage. Hence, CT is still the mainstay in imaging in the emergency room. Head trauma, suspected sub-arachnoid hemorrhages and fractures of the facial and temporal bones are examples.

CT is comparatively cheap and in available is most of the referral hospitals and all tertiary care centers.

A standard CT examination of the head consists of a series of contiguous tomographic sections usually 5 – 10 mm thick from the posterior arch of atlas to the vertex. Most adult head can be covered in 15 – 20 sections. In the interest of speed some units prefer to perform a

helical scan of the head, which takes little more than 30 seconds, accepting a small reduction in image quality. In general, the modification consists of thinner section (1.5 – 3mm), changes in the plane of sections, magnification of areas of interest and the use of contrasts media, usually intravenous or intrathecal.

Contrast media used for CT are:

A. Intravenous : Water soluble iodinated media

B. Intrathecal : a. Water soluble iodinated media

b. Gaseous : air or Xenon

C. Inhalational : Xenon

Contra indications for intravenous contrast media are history of previous allergy impaired renal functions, asthma, multiple myeloma and sickle cell anemia.

Indications for I.V contract medium hinge on the assumption that abnormalities in the blood brain barrier (other than cerebral edema) will be present or that a hypervascular lesion will be found. Most primary and secondary intracranial tumors and AV malformations, particularly those over the tentorium, are visible without contrast media, but the significantly increased accuracy of diagnosis makes contrast enhanced scanning the method of choice. Infective or inflammatory processes, certain aneurysms and a small proportion of extracerebal collections

may also benefit diagnostically from I.V contract medium. However in none of these categories is the detection rate usefully increased. The preferred CT technique in stroke is without contract medium although the latter may be given if perusal of the initial images suggests an alternative diagnosis. Ideally all patients should be scanned in the first instance without I.V. contrast medium so that the decision as to whether contract medium should be used is based on the clinical and imaging findings in each case.

MRI[21, 22, 23] is more sensitive than CT scan as an imaging modality in investigating seizure disorders and it is more specific too. MRI utilizes the magnetic properties of H_+ ions in tissues when subjected to a powerful magnetic field. MRI can be used to study CNS lesions like neoplasm, cerebral edema, cerebral edema, demyelinations, degenerative disease and congenital anomalies. MRI is also routinely used for evaluation of those patients who are potential candidates for epilepsy surgery, e.g.:Mesial temporal sclerosis. The contrast agent used in MRIs Gadolinium – DTPA. The use of MRI for evaluation of epilepsy in our country is not widespread because of its non availability and high cost.

Positron Emission Tomography (PET) and single Photon Emission Computerised Tomography (SPECT) are used to study cerebral regional blood flow, metabolic activity and glucose utilization.

PET and SPECT can be used to determine the site of origin of seizures. In a recent study by Theodore et al, presence of glucose hypometabolism was found in the left temporal lobe of 70 – 80% of patients with temporal epilepsy, who have undergone surgery. But even in affluent countries these investigative modalities are still largely used as research tools only.

Hyperglycemia

Pathophysiology of hyperglycemia [1, 27, 31]

The findings of the Diabetes Control and Complications Trail (DCCT) have confirmed that hyperglycemia is the one single cause of cellular toxicity and hence, of complications. In vitro and in vivo works has demonstrated that excess glucose, together with genetic and environmental factors causes biochemical alterations that affects specific metabolic pathways leading to organ damage and loss of function. These changes include:

- Polyol pathway disruption
- Glycation / oxidation disruption
- Protein kinase C synthesis activation
- Altered gene expression and
- Lipoprotein alterations.

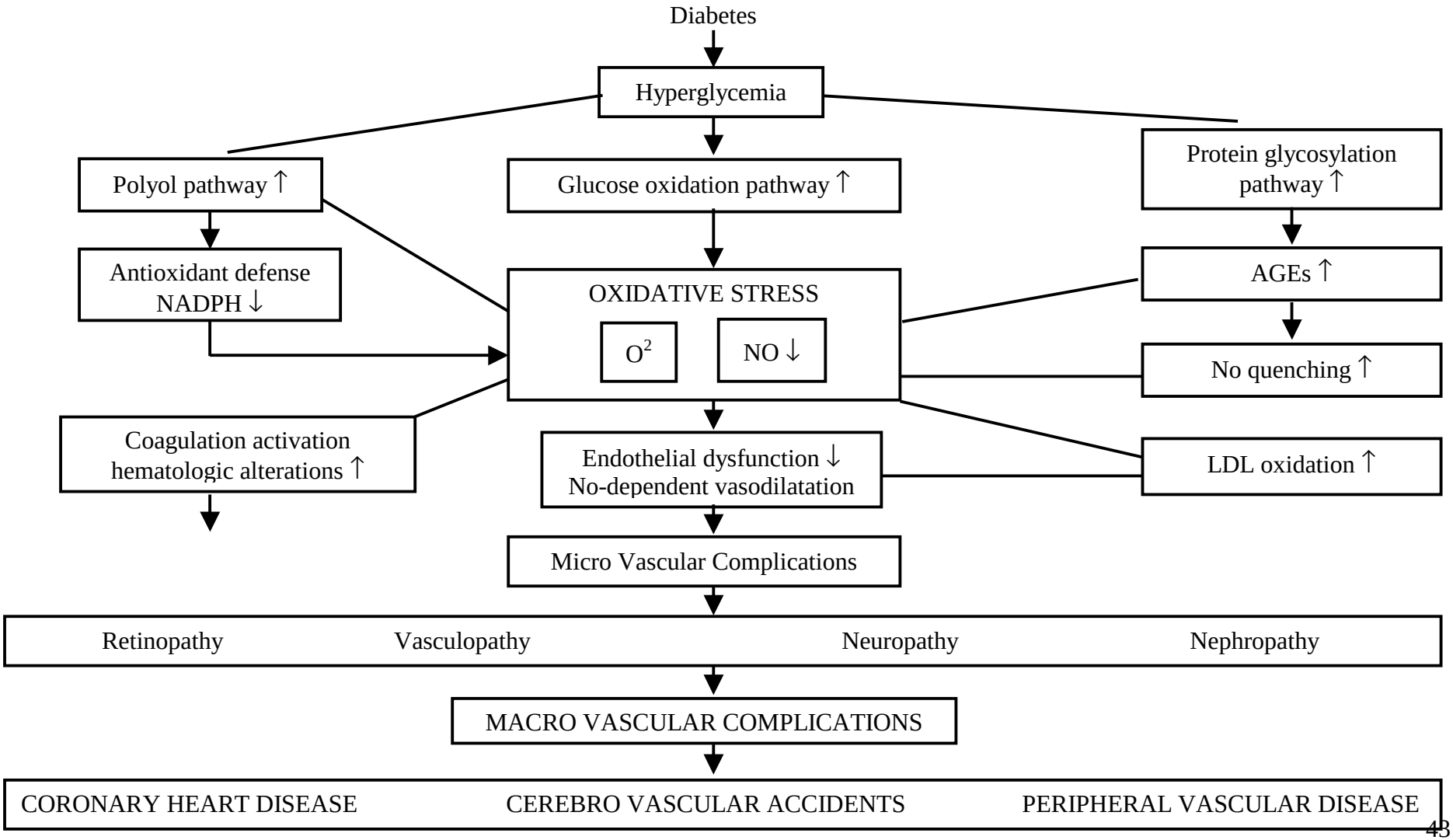
The hypothetical link between hyperglycemia and diabetic complications Ref. Flow chart 1.

The role of Glucose Transport changes in the pathogenesis hyperglycemia:

Glucose transport participates in secretory B cells response (GLUT – 2) Hepatic Glucose Production (HGP); peripheral stimulation of glucose transport in target tissue (GLUT – 4) skeletal muscle accounts for 80% of the glucose disposal.

Flow chart No. 1

HYPOTHETICAL LINKS BETWEEN HYPERGLYCEMIA AN DIABETIC COMPLICATIONS



GLUT 4 is the major glucose transporter expressed in striated muscle. GLUT 4 translocation might be the mechanism responsible for insulin, mediated glucose disposal. Hence, chronic exposure to hyperglycemia and hyperinsulinemia reduces the maximal insulin-induced glucose transport rate by inhibiting transporter translocation.

Hyperglycemic state [1, 4]

Hyperglycemic state is said to occur when there is sustained rise of Blood Glucose (BG) beyond definite limits

1. DIABETES : FPG > 126mg/dl, PPPG > 200mg/dl
2. IGT:FPG = 110 – 125mg/dl, PPPG = 140 – 200mg/dl
3. IFG:FPG > 100mg/dl

Factors leading to hyperglycemia (HPIM 16 ED)

1. Decreased hepatic glucose uptake
2. Decreased hepatic glycogen synthesis
3. Hepatic resistance to Insulin.
4. Porto systemic glucose shunting
5. Peripheral insulin resistance
6. Humoral abnormalities (Serum)

   ↑ Glucagon

   ↓ Cortisol

   ↑ Insulin (↓ in Haemochromatosis)

Hyperglycemic status – causes

- Diabetes (Decreased Insulin secretion and Impaired Insulin action)
- Impaired Fasting Glucose
- Transient Hyperglycemia
- Gestational Diabetes – IFG
- Previous abnormality of Glucose Tolerence

Mechanism of Hyperglycemic seizures: [57, 58]

1. The Brain glucose utilization is reduced in non ketotic hyperglycemia, an increased rate of GABA utilization via the GABA shunt may be one of the sources of energy requirements, thereby further lowering the GABA level and reducing the threshold of seizure activity.
2. It seems, that an acute cerebral infarct or an older infarct, a scar formation, is triggered to produce focal epileptic activity by the superimposed metabolic disturbances especially hyperglycemic and hyponatremia.
3. Ketotic hyperglycemia is less frequently associated with seizure possibly because of the antiepileptic effect of ketosis.
4. Practically all, patients who present with epilepsia partials continua should have immediate determination of blood glucose levels.

Hyperglycemic seizures – Diagnosis

In the absence of Ketosis in Diabetes patients with Hyperglycemia produce

1. Abnormal movements like Asterixis
2. Paroxysmal Choreoathetosis
3. Partial epileptic seizures: motor / jacksonian.

It may be the initial or first manifestations of Diabetes Mellitus.

It may occur in 19% of patients with metabolic abnormalities of Non Ketotic Hyperglycemia.

The prompt management with Insulin and correction of Dehydration and osmolality help for early recovery in these patients (HPIM 16 ED).

MATERIALS AND METHODS

MATERIALS AND METHODS

This is study included 50 patients diagnosed as Hyperglycemic Seizure on the basis of clinical evaluation Biochemical investigations and CT scan Brain and Electro Encephalographic studies, who were admitted to the Medical wards including neurology and Intensive Medical care units of Thanjavur Medical College Hospital, Thanjavur during November 2004 to July 2006.

PATIENT SELECTION:

The following patients were included:

1. Patients taken for this study includes Patients admitted with first time convulsions who was later found to be Diabetic and whose first admission Blood Sugar was in Hyperglycemic level.
2. Known Diabetic patients who had focal neurological symptoms / convulsions whose Blood sugar during convulsions showed Hyperglycemic Seizure level.
3. Other Systemic problem patients who had convulsions during their hospital stay and showed Hyperglycemic level of Blood glucose and later who were diagnosed as Diabetic patients.

The following patients were excluded:

All patients with Seizure disorder of varying etiology without Hyperglycemia.

Patients with Diabetes and Cerebo vascular accidents without convulsions.

Patients with previously known Structural Brain disorder with seizures or patients with convulsions following IV Glucose.

Hyperglycemic Seizures was diagnosed on the basis of Diabetic patients who had Hyperglycemia with:[9,57]

1. Abnormal involuntary Movements.
2. Paroxysmal choreo athetosis.
3. Focal Seizures
4. Generalized Tonic Clonic Seizure (GTCS).
5. Epilepsia partialis continua.

The detailed History and clinical examinations were done as outlined in the proforma and they were subjected to routine haematological, Biochemical investigations, CT scan evaluation including other systemic problem oriented evaluation. EEG studies was done in all patients.

SERUM OSMOLALITY

The serum Osmolality was calculated from the following formula:

SERUM OSMOLALITY

$$= 2 \times [Na^{+} + K^{+}] + \frac{\text{Blood Glucose in mgs}}{18} + \frac{\text{Blood Urea Nitrogen}}{2.8}$$ [4]

$$= 2 \times [Na^{+} + K^{+}] + \frac{\text{Blood Glucose in mgs}}{18} + \frac{\text{Blood Urea in mgs}}{6}$$ [26]

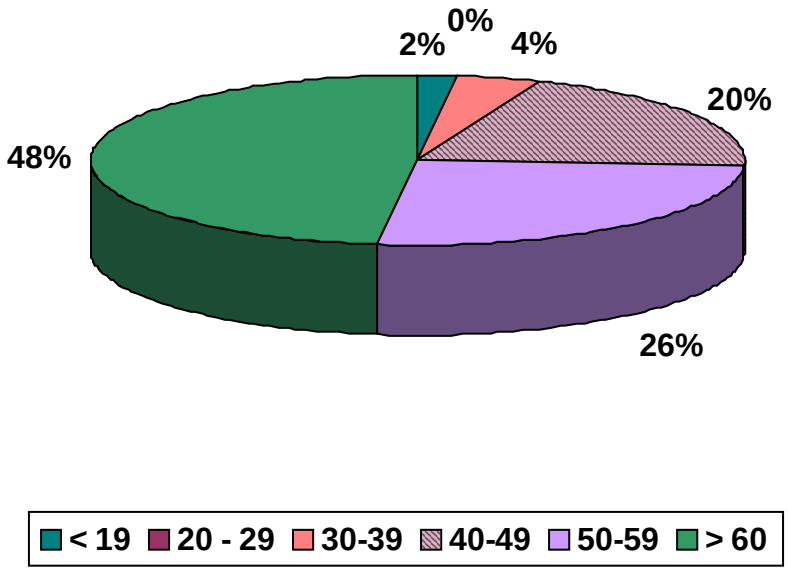
Serum Osmolality Normal Range = 275 to 295 mosm / kg [24]

1 mosm of Gulcose equals = 180mg/l or 18mg/dl [4]

Urea Nitrogen equals = 28mg/l or 2.8 mg/dl [24]

RESULTS AND OBSERVATION

PIE DIAGRAM SHOWS THE AGE DISTRIBUTION



RESULTS AND OBSERVATION

The total number of patients in this study was 50. The study was done during the period of November 2004 – July 2006 in Thanjavur Medical College Hospital.

AGE DISTRIBUTION

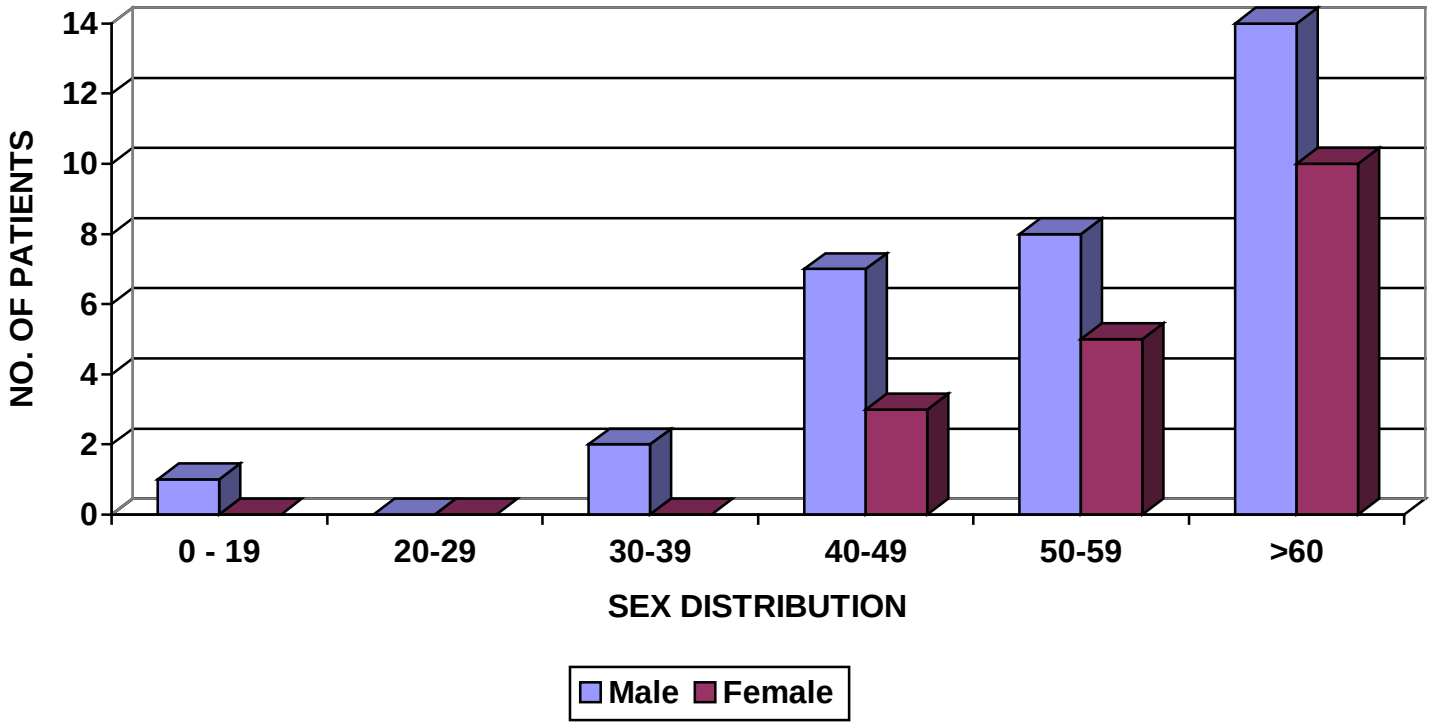
Table – I

Sl. No.	Details	No. of Patients with Hyperglycemia seizure diagnosed	Percentage for Total Patients
1	Age < 19 Years	1	2%
2	Age 20 – 29 Years	0	0%
3	Age 30 – 39 Years	2	4%
4	Age 40 – 49 Years	10	20%
5	Age 50 – 59 Years	13	26%
6	Age > 60 Years	24	48%
	Total	**50**	**100%**

The total number of patients included in the study was 50. Out of which 1 patient belong to the age group of less than 20 years. The youngest of them was 18 years old. 2 patients belong to age group of 30 – 39 years. 10 patients belong to age group of 40 – 49 years. 13 patients belong to age group of 50 – 59 years. 24 patients belong to age group of above 60 years.

13 patients were below the age of 50 years. 37 patients were above the age of 50 years.

BAR DIAGRAM SHOWS THE SEX DISTRIBUTION



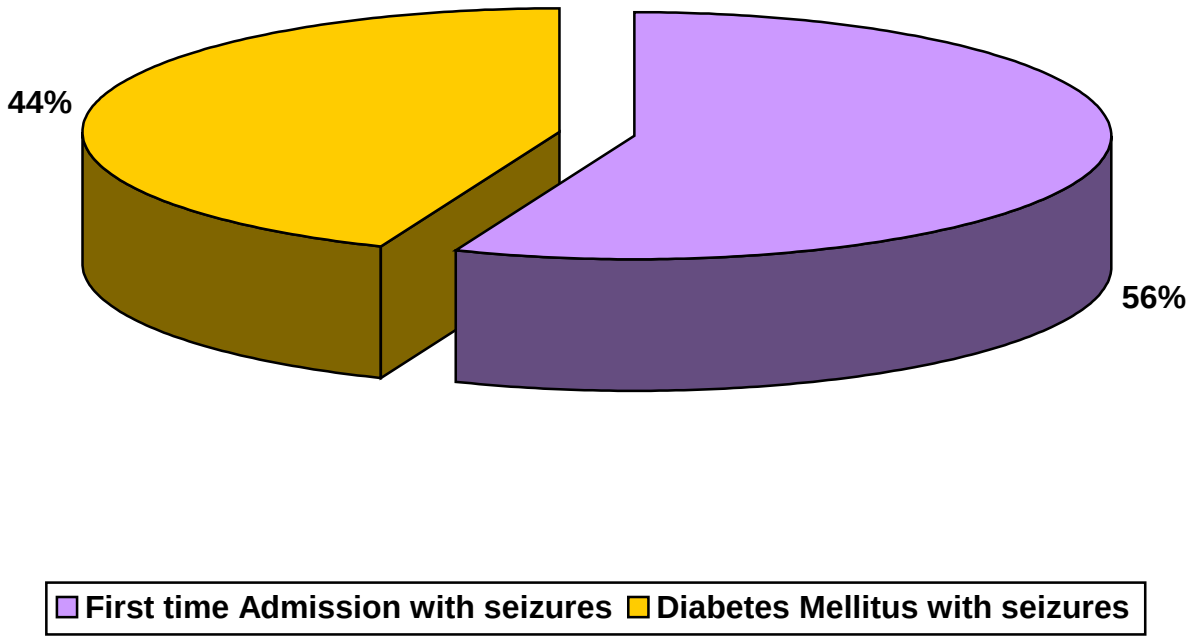
SEX DISTRIBUTION

Table – II

Sl. No.	Details	Male	Female	Total
1	Age < 19 Years	1	0	1
2	Age 20 – 29 Years	0	0	0
3	Age 30 – 39 Years	2	0	2
4	Age 40 – 49 Years	7	3	10
5	Age 50 – 59 Years	8	5	13
6	Age > 60 Years	14	10	24
	Total	**32**	**18**	

Out of 50 patients, 32 were male patients and 18 were female patients.

PIE DIAGRAM SHOWS THE ADMISSION STATUS



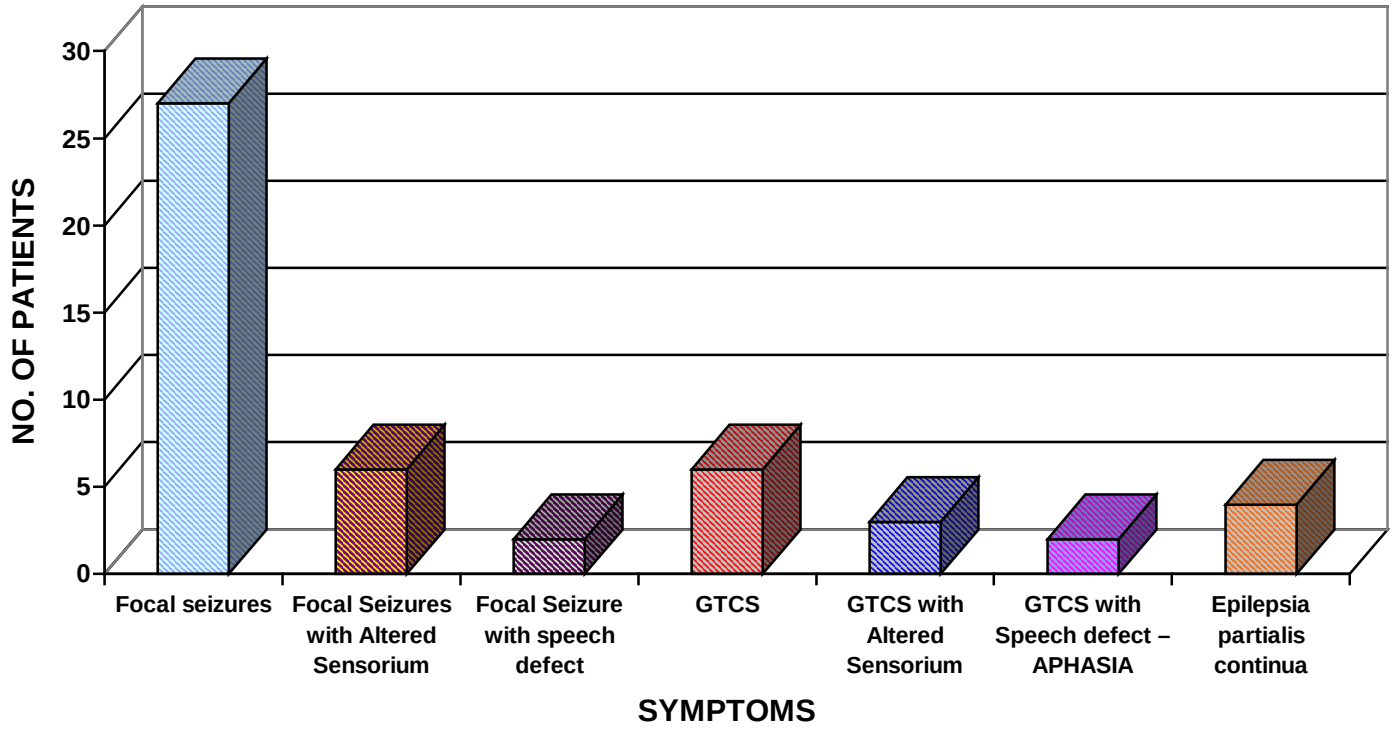
ADMISSION STATUS

Table - III

Sl. No.	Details	No. of Patient Out of 50 patients	Percentage for total patients
1	First time admission with seizures	28	56%
2	Diabetes Mellitus with seizures	22	44%

Out of 50 study patients, 28 patients had first time seizure without known Diabetes. 22 patients had diabetes with seizures.

ANALYSIS OF SYMPTOMS SIGN OF HYPERGLYCEMIA

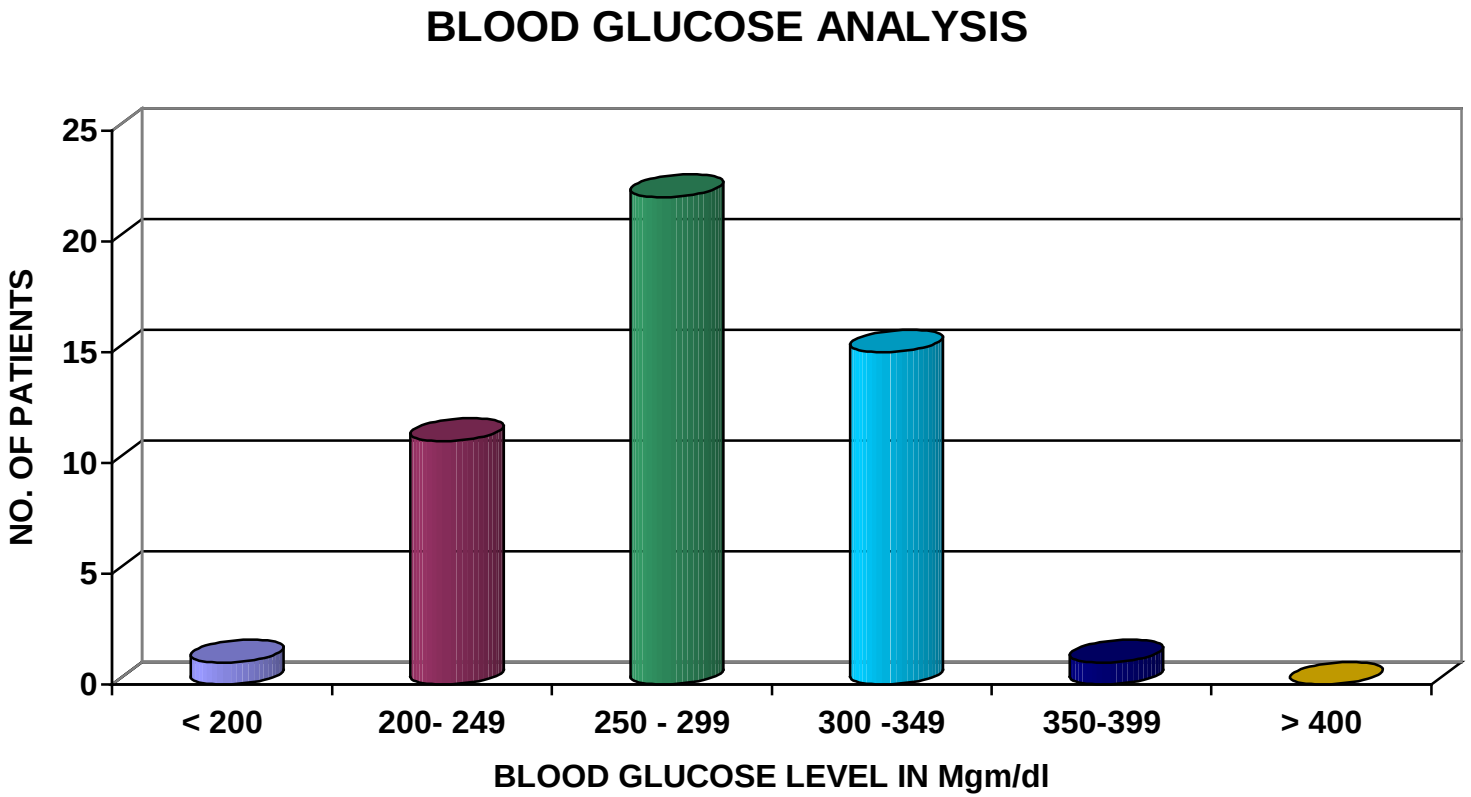


ANALYSIS OF SYMPTOMS SIGN OF HYPERGLYCEMIA

Table - IV

Sl. No.	Details of symptoms	No. of patients	Percentage for Total Patients
1	Focal seizures	27	54%
2	Focal Seizures with Altered Sensorium	6	12%
3	Focal Seizure with speech defect	2	4%
4	GTCS	6	12%
5	GTCS with Altered Sensorium	3	6%
6	GTCS with Speech defect – APHASIA	2	4%
7	Epilepsia partialis continua	4	8%
	Total	**50**	**100%**

Out of 50 patients, 35 patients had focal seizure and 11 patients had generalized tonic clonic seizure, 4 patients had epilepsia partialis continua features.


BLOOD GLUCOSE ANALYSIS
NO. OF PATIENTS
25
20
15
10
5
0
< 200
200- 249
250 - 299
300 -349
350-399
> 400
BLOOD GLUCOSE LEVEL IN Mgm/dl

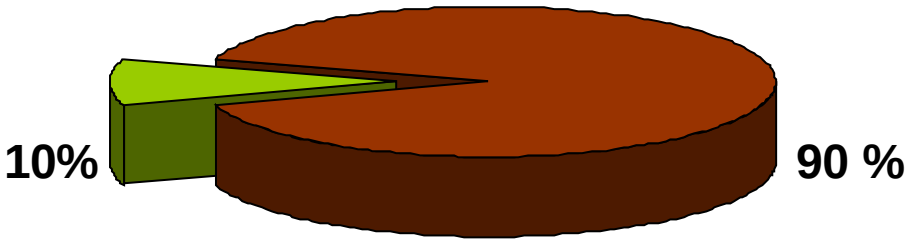
BLOOD GLUCOSE ANALYSIS

Table – V

Sl. No.	Blood glucose level in Mgm/dl	No. of patients	Percentage for Total no. of Patients
1	< 200	1	2%
2	200 – 249	11	22%
3	250 – 299	22	44%
4	300 – 349	15	30%
5	350 – 399	1	2%
6	> 400	0	0%
	Total	**50**	**-**

Among the 50 cases, 1 patient had blood sugar < 200 mg/dl and patients had blood sugar level was 200 – 249 mg/dl. 22 patients had 250 – 299 mg/dl. 15 patients had 300 – 349 mg/dl. One patient had 350 – 399mg/dl. None of the patient had found blood glucose level above 400 mg/dl.

OSMOLALITY ANALYSIS



NORMAL (275 - 295) Abnormal – above 295

OSMOLALITY ANALYSIS

Table – VI

Sl. No.	Serum Osmolality in m.osm/L	No. of Patients	Percentage for Total no. of Patients
1	Normal (275 – 295)	5	10%
2	Abnormal – above 295	45	90%
Total		**50**	**-**

Among 50 patients serum osmolality was normal in 5 patients. 45 patients had hyperosmalality.

ACETONE ANALYSIS

Table – VII

	Plasma acetone	Percentage	Urine acetone	Percentage
Positive	1	2%	1	2%
Negative	49	98%	49	98%

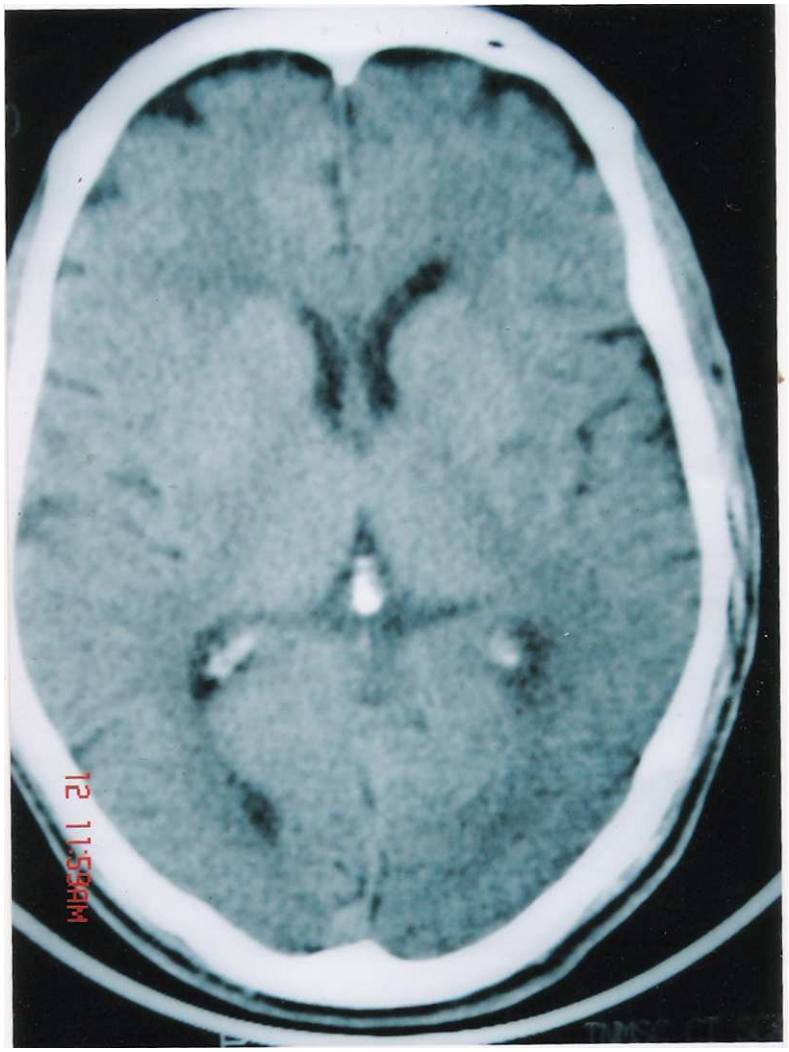
Among 50 patients, Plasma acetone and Urine acetone was positive in 1 patient.

CT SCAN BRAIN ANALYSIS

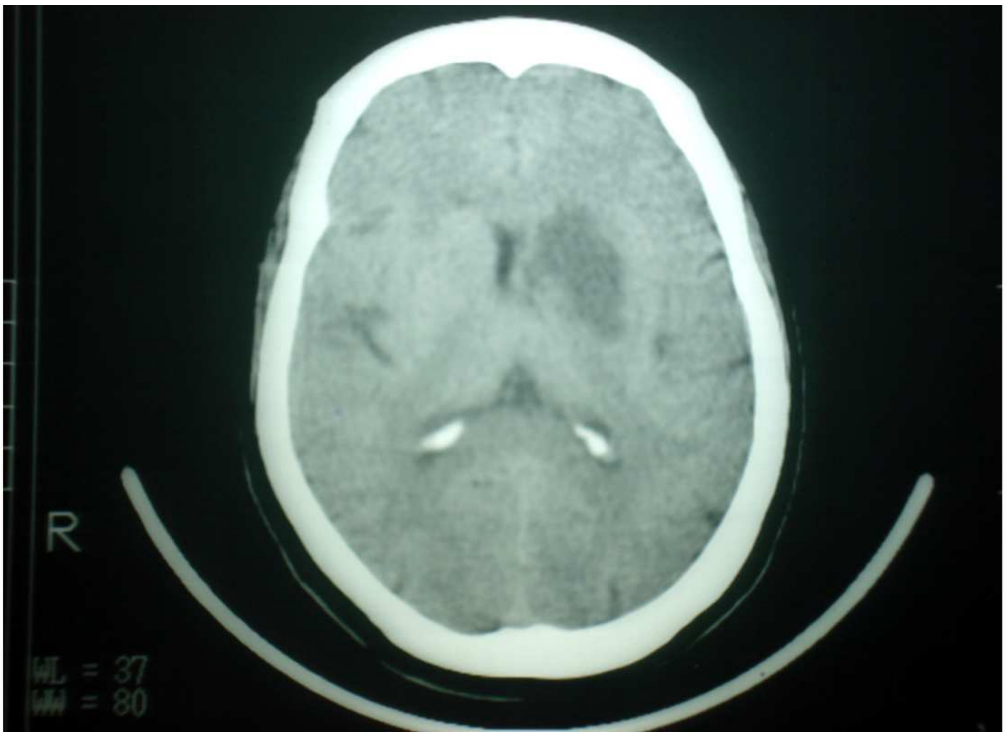
Table – VIII

Sl. No.	Details		No. of Patients	Percentage for Total No. of Patients
1	Normal		36	72%
2	Abnormal			
	a)	Infarct	13	26%
	b)	Cortical Atrophy	1	2%
		Total	**50**	**-**

Out of 50 study patients, 36 patients had normal CT Scan and 14 had abnormal CT scan. In among 14 patients, 13 patients had infarct in the CT scan and 1 patient had cortical Atrophy.

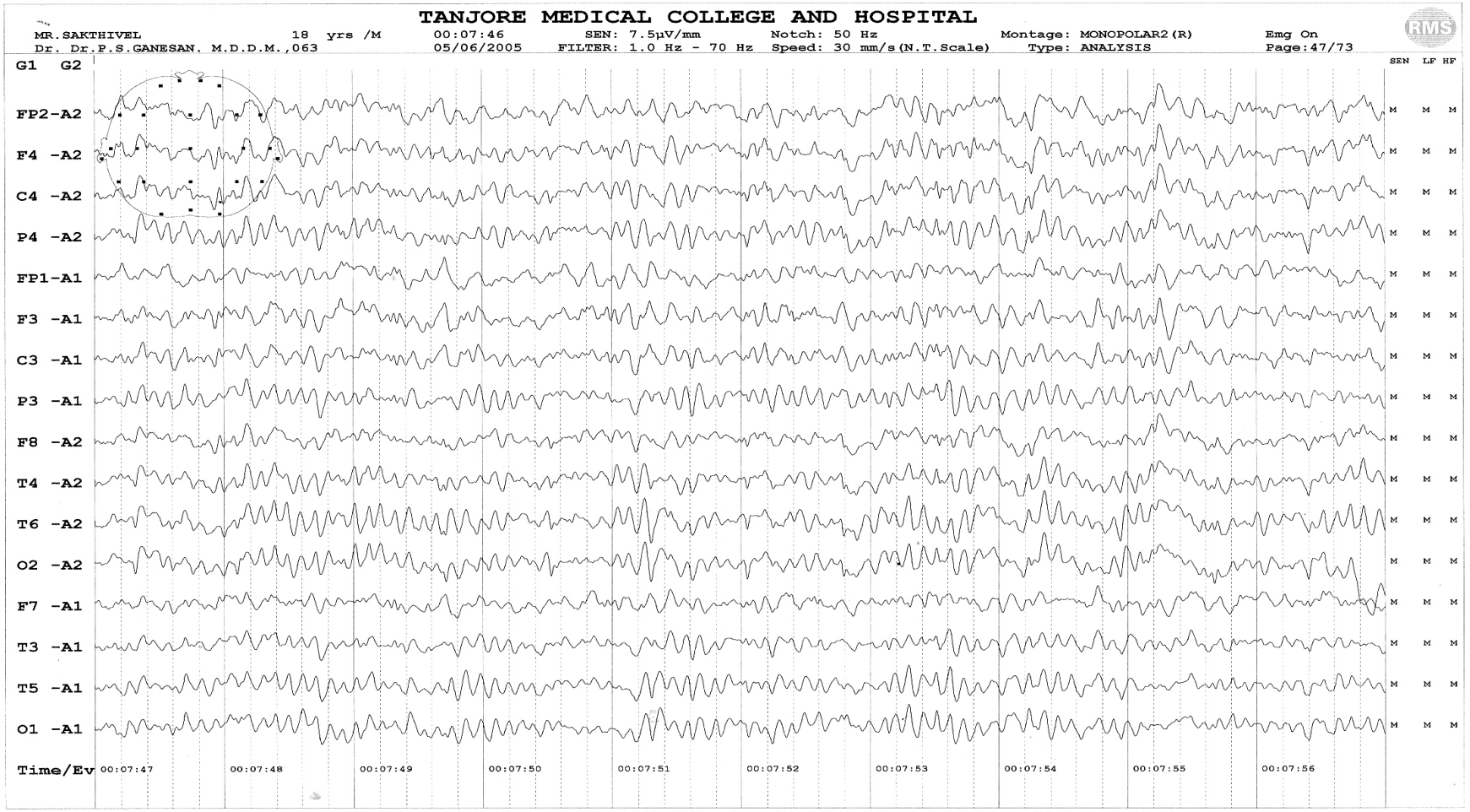


CT SCAN SHOWING NORMAL STUDY



CT SCAN SHOWING LEFT CAPSULO GANGLIONIC INFARCT

EEG SHOWING INTERMITTENT SPIKE AND SHARP WAVE DISCHARGE ON LEFT FRONTO PARIETAL REGION



EEG ANALYSIS

Table - IX

Sl. No.	Details		No. of Patients	Percentage for Total No. of Patients
1	Normal		42	84%
2	Abnormal			
	a)	Bilateral epileptiform moves on right side	4	8%
	b)	Bilateral epileptiform moves on left side	2	4%
	c)	Intermittent spike and sharp waves discharge on left parietal leads	2	4%
		Total	**50**	**100%**

Out of 50 study patients, 42 patients had normal EEG and 8 patients had abnormal EEG. In among 8 patients, 2 patients had intermittent spike and sharp waves discharge on left parietal leads, and 4 patients had bilateral epileptiform moves on right side and 2 patients had epileptiform moves on left side.

DISCUSSION

DISCUSSION

50 patients who presented with new onset seizure and hyperglycemia were analysed as follows:

Maccario et al has shown that seizures occurred as the first manifestation of Non Ketotic Hyperglycemia.

The occurrence of seizure as a presenting features of Hyperglycemia with Non Ketotic Hyperglycemia was first emphasized by *Maccario et al.* in 1965. [39]

Age and Sex:

In a study conducted by *Maccario et al* seizures occurred as the first manifestation of diabetes in patients above 60 years.

In our study 46% of patients had new onset seizures were above 60 years. They were found to have Non Ketotic Hyperglycemia

Lammouchi T, Grira M, et al,[55] studied 22 cases. 11 out of 22 cases diabetes mellitus had not been diagnosed previously. In our study 28 out of 50 cases were not diagnosed previously.

Seizure types in Hyperglycemia:

In a study conducted by *Vargese K.S, et al,*[41] Focal seizure with (or) without generalization occurred in 65% of patients.

In our study Focal seizure without generalization occurred in 58% (29/50) case. Focal seizure with generalization occurred in 12% (6/50) cases.

Primary generalized seizure occurred in 22% of patients (11/50 cases).

Rector WG,[54] Reviewed 158 cases, in his study 44% cases were focal seizure. 18% of cases were generalized seizures.

Scherer C,[40] studied patient more than 50 years, in his study partial motor seizure occurred 65% of patients. In our study 70% of patients had focal motor seizure.

Venna N, Sabin T.D.,[56] study showed that focal seizure is the commonest, type in Diabetes Mellitus. Hyperglycemia is the strongest risk factor for focal seizure and stroke.

Epilepsia Partialis Continua:

Epilepsia Partialis Continua is one of the early presentation of Non Ketotic Hyperglycemia.

In our study Epilepsia Partialis Continua occurred in 8% of patients.

Singh BM et al,[42] studied 21 patients with seizures. He showed Epilepsia Partialis Continua occurred in 9 patients [9/21 →43%] with Non Ketotic Hyperglycemia.

Lammouchi T, Grira M, et al,[55] studied 22 patient with Non Ketotic Hyperglycemia. Out of which 14% presented with Epilesia Partialis Continua in his study.

Singh and Strobos,[28] 1980, studied 158 cases and his study showed 10 patient (6%) had Epilepsia Partialis Continua and in our study 8% of patients with Non Ketotic Hyperglycemia had Epilepsia Partialis Continua.

In addition, patients studied in the above literature had hyponatremia and hyperosmolality along with Non Ketotic Hyperglycemia.

In our study, 4 patients had hyponatremia and hyperosmolality along with Non Ketotic Hyperglycemia.

Blood sugar:

In our study, mean blood sugar was 277.3 mg / dl with the range of blood sugar was 191 – 398 mg/dl.

In two studies conducted by *Grant C, Charles Warlow, et al,*[46] range of blood sugar was 234 mg / dl to 600 mg / dl among the patients with Non Ketotic Hyperglycemia.

In another study by *Scherer C,*[40] observed that the mean blood sugar level was above 340 mg / dl in patients presented with focal seizures and Non Ketotic Hyperglycemia.

Supachai Paiboonpal et al,[59] studied 22 patients with Epilepsia Partialis Continua and observed range of blood sugar was 324 – 742 mg/dl in both Ketotic and Non Ketotic Hyperglycemia.

In another study by, *Venna N, Sabin et al,* showed hyperglycemia is intrinsically epileptogenic and levels of blood glucose triggering seizures may be as low as 14 – 20 mmol /L (252 – 360 mg/dl).

The incidence of blood glucose level with which hyperglycemic seizures occurred in our study is comparatively less than their studies (191 – 398mg/dl).

James C. Kolb,[52] seizures hyperglycemia evaluate the frequency and type of seizure and glucose level of patient. Level of alterness he evaluated in 813 patients with blood glucose level above 400 mg and observed only 8 out of 813 patients (1%) had seizures with Non Ketotic Hyperglycemia. He concluded that focal or generalized seizure induced by hyperglycemia occurred in the absence of precipitating factors. This study also showed that seizures are rare with blood glucose more than 400 mg / dl. In our study patients with blood sugar value more than 400 mg had no seizures.

Diabetic Keto Acidosis:

Engel and Pedley[9] studied, ketotic hyperglycemia is less frequently associated with seizure possibly because of the antiepileptic effect of ketosis.

A study by *J.J. Mc. Murray*[51] observed that seizures are not seen in Diabetic ketosis because ketones have an antiepileptic effect.

Vargees KS, et al, studied 40 cases and observed none of the patients with Diabetic Ketoacidosis had seizures.

Scherer C, observed that in the absence of ketoacidosis seizures occurred more frequently.

In our study 2% of patients with Diabetic Ketoacidosis had seizures.

Hyperosmolality:

In our study, 90% of patients had increased osmolality with range between (295 – 330m.osm/l), 5 cases (10%) had serum osmolality in the normal range (275 – 295m.osm/l).

Vargese K.S, et al studied 40 patients with Seizure and hyperglycemia observed in 90 % of study group had increased serum osmolality.

Scherer C,[40] observed seizure occurs if serum osmolality is normal or slightly elevated.

Lammouchi T, Grira M, et al[55] studied 22 patients with Non Ketotic Hyperglycemia and observed that the serum osmolality increased in all 22 cases with mild to moderate extent. (266 – 309.2 m.osm/l)

In our study, 90% of cases had serum osmolality above 295m.osm/l.

Wasterlain CG Berkovic SF,[57,58] reviewed 22 patients with Epilepsia Partialis Continua. Patients with Epilepsia Partialis Continua had serum osmolality 301.7 m.osm/l.

In our study, 4 Patients with Epilepsia Partialis Continua had serum osmolality above 295 m.osm/l.

CT Scan Brain:

In our study, 36 out of 50 patients (72%) had normal CT Scan Brain. In the remaining 14 cases, 13 patients (26%) had infarct and one patient (2%) had cortical atrophy.

Vargese K.S, et al studied 40 cases out of which 24 patients (60%) had normal CT Scan Brain and 16 patients (40%) with seizures had infarct.

Lammouchi T, Grira M, et al[55] studied 22 cases out of which 17 patients had normal CT scan Brain. In our study, 72% of patients had normal CT Scan Brain.

EEG

In our study, 8 out of 50 (16%) with hyperglycemic seizures had abnormal EEG.[9,34]

In our study, 10 patients with hyperglycemia seizure had associated with systemic disease. In among 10 patients, 3 patients had hypertension and CAHD but had no evidence of Hypertensive Encephalopathy.

5 patients had renal failure. Probably the seizure associated with these patients may be due to Hyperglycemia or Uremia.

2 patients with hypothyroidism had seizure associated with hyperglycemia.

Almost all patients recovered completely with routine line of management with insulin, anti epileptics and dehydration correction. However, irrespective of management 2 patients had status epilepticus and died and 2 patients had developed coma and died.

CONCLUSION

CONCLUSION

HYPERGLYCEMIC SEIZURES is a special neuro – endocrine syndrome. Seizures can manifest as the first symptom of Diabetes Mellitus.

Hyperglycemic seizures can occur in Ketotic and Non Ketotic Hyperglycemia but commonly in patients with non ketotic hyperglycemia. Hyperglycemic seizures is rarely associated with Diabetic Keto acidosis.

Generalized tonic clonic seizure as the first manifestation of Non Ketotic hyperglycemia is found to be rare.

Hyperglycemic seizures occurred commonly above the age of 50 years and the incidence is more in males.

Most of the patients with hyperglycemic seizures had blood glucose value between 250 – 300 mg/dl.

In our study the mean blood glucose value was 277.3 mg/dl among patients with hyperglycemic seizures.

The minimum blood sugar value at which hyperglycemic seizure occurred was 191 mg/dl and maximum blood sugar value at which hyperglycemic seizures occurred was 398 mg/dl.

The osmolality was above the normal range in the maximum of 90% of cases.

The CT Scan brain evaluation showed normal without structural brain lesion in 72% of patients.

EEG was normal in majority of patients with Non Ketotic hyperglycemic seizures.

The correction of Non Ketotic hyperglycemia with insulin and IV fluids showed early and complete recovery.

From the above study, it is shown that all patient with new onset seizures above the age of 50 years should also be thought of Diabetes Mellitus and evaluated for it.

PROFORMA

EVALUATION OF CLINICAL PROFILE OF HYPERGLYCEMIC SEIZURES

NAME: **AGE/SEX:** **M/F**

IP. No.: **WARD:** **OCCUPATION:**

ADMITTING COMPLAINTS:

a. CONVULSIONS ☐ c**.** FOCAL NEURO LOGICAL ☐
SYMPTOMS

b. UNCONSCIOUSNESS ☐ d**.** OTHERS ☐

HISTORY OF FITS:

a. WHETHER, SINGLE SEIZURE ☐ REPEATED SEIZURE ☐

b. TYPE OF SEIZURE: FOCAL / GTCS / EPC / EME / CPS / TLE / PLEDS / GCSE / MYOCLONIC / NCSE / GEVS / PARTIAL MOTOR SEIZURE / NOCTURNAL

ASSOCIATED CONDITION: LOC / POST ICTAL CONFUSION / RESIDUAL PROBLEM

PAST HISTORY:

a. DIABETES ☐ **c**. CAHD ☐ / COPD ☐ / TB ☐

b. HYPERTENSION ☐ d. OTHERS ☐

TREATMENT HISTORY:

a. DIABETIC TREATMENT: OHA ☐ INSULIN ☐

b. NO TREATMENT ☐ OTHERS ☐

EXAMINATION:

a. PALLOR c. JAUNDICE

b. FEVER

VITAL SIGNS: PULSE: BP (mm / Hg):

EXAMINATION OF CENTRAL NERVOUS SYSTEM:

1. HIGHER FUNCTIONS: 3. SENSORY SYSTEM: N / + / -

a. Conscious / Confusion + / - 4. MOTOR SYSTEM:

b. Stupor / Coma + / - a. Mono Paresis R/L:UL/LL + / -

c. Speech: N / + / - b. Hemi Paresis R/L:UL/LL + / -**2.**

CRANIAL NERVES: CN: PALSY R/L + / - c. Quadri Paresis + / -

5. OTHERS + / -

OTHER SYSTEMS: CVS: RS: ABDOMEN:

DIABETIC COMPLICATIONS:

1. NEPHROPATHY: MICRO / MACRO / AZOT ☐ 4. RETINOPATHY ☐

2. NEUROPATHY: PN / MN ☐ 5. OTHERS ☐

AMYO / DIAB - FOOT ☐

3. ANS: GASTOPATHY / ORTHO HT / IMPOTENCE / BLADDER DISTURBANCE ☐

INVESTIGATION:

Blood HB gm% Tc: Dc: P. L. E. M.

BIO-CHEMISTRY Date :		
Blood Sugar (Random) (mg/dl) :		
(Fasting) (mg/dl) :		
(PP) (mg/dl) :		
Plasma Acetone		
Blood Urea (mg / dl)		
Serum Creatinine (mg / dl)		
Serum Sodium (Meq / L)		
Serum Potassium (Meq / L)		
Serum Osmolality (m.osm/L)		
Urine Albumin		
Urine Acetone		
Others		

ECG	
CHEST X RAYS	
CT SCAN BRAIN	
EEG	

OUTCOME:

1. RECOVERY WITH :

a. OHA ☐

b. INSULIN ☐

c. AED: DPH / CBZ / SVP / GAR

2. TOTAL RECOVERY ☐

3. PARTIAL RECOVERY ☑

4. DIED ☐

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MASTER CHART

No	Name	Age	Sex	Hospital number	Admission complaints			Seizure details			Blood sugar during seizures	Urea	Creatnine	Electrolytes		Osmolality	Acetone		CT scan brain report	EEG report	Other systemic problems	Treatment for DM I : Insulin O:OHA	Treatment for seizures DPH.IV, CBZ, SVP, GAR	Result TR: total recovery, PR: partial recovery, D: Died
					First time seizures	DM with seizures	Focal neurological defects / no. of repeated seizure	Focal seizures	GTCS	Other types	In mgs / dl	In mgs / dl	In gs / dl	Sodium in me q/l	Potassium in me q/l	In m.os mol.	Plasma	Urine						
1	ARUMUGAM	48	M	828728	+	-	-	RF	-	-	256	21	0.8	140	4.3	307.1	-	-	Normal	-	-	I	DPH.IV	TR
2	RAJAMMAL	60	F	830080	+	-	-	RF	-	-	236	40	1.5	140	5.0	309.9	-	-	Normal	-	-	I	DPH.IV / CBZ	TR
3	PONNAIYAN	65	M	831773	+	-	-	RF	-	Altered sensorium	284	32	1.0	144	4.3	317.2	-	-	Left Subcortical infarct	-	-	I	DPH	Recovery from Fits
4	RAMADAS	48	M	833255	+	-	-	LF	-	-	220	146	9.8	141	6.0	330.5	-	-	Normal	-	Chronic renal failure	I	DPH.IV / CBZ	TR
5	VIYAKULAM	60	F	834594	+	-	-	LF	-	-	312	31	1.2	132	4.4	295	-	-	Normal	-	-	I	DPH	TR
6	DURAIRAJ	60	M	836091	+	-	2	RF	-	-	254	48	1.4	133	4.7	297.8	-	-	Left parietal infract	Abnormal Record	-	I	DPH.IV / CBZ	TR
7	MUNUSAMY	52	M	837148	+	-	-	IF	-	-	276	42	1.0	145	4.0	320.3	-	-	Right Subcortical infarct	-	Diabetic Left foot	O	DPH	TR
8	KAMATCHI	62	F	838469	+	-	-	RF	-	-	260	23	1.0	142	3.8	309.8	-	-	Normal	-	-	O	DHT	TR
9	SAMINATHAN	45	M	839756	-	+	-	-	+	Dysarthria	240	34	1.5	132	4.0	292.9	-	-	Normal	-	-	O	DPH.IV / CBZ	TR
10	PITCHAI	62	M	840435	+	-	3	RF	-	-	342	41	1.6	135	5.2	306.2	-	-	Normal		-	I	DPH.IV / CBZ	TR
11	VADIVEL	75	M	840957	-	+	2	EPC	-	-	324	24	0.7	132	4.8	295.6	-	-	Normal		-	I	DPH	Died
12	KAVERI	70	F	841626	+	-	3	RF	-	-	318	40	1.6	139	4.7	311.7	-	-	Cortical atorpy Dilateral ventricle		LBBB in ECG with CRF	I	DPH / CBZ	TR

No	Name	Age	Sex	Hospital number	Admission complaints			Seizure details			Blood sugar during seizures	Urea	Creatnine	Electrolytes		Osmolality	Acetone		CT scan brain report	EEG report	Other systemic problems	Treatment for DM I : Insulin O:OHA	Treatment for seizures DPH.IV, CBZ, SVP, GAR	Result TR: total recovery, PR: partial recovery, D: Died
					First time seizures	DM with seizures	Focal neurological defects / no. of repeated seizure	Focal seizures	GTCS	Other types	In mgs / dl	In mgs / dl	In gs / dl	Sodium in me q/l	Potassium in me q/l	In m.os mol.	Plasma	Urine						
13	GUNASEKARAN	60	M	842763	+	-	-	RF	-	-	398	44	1.6	140	5.2	320	-	-	Normal	-	-	I	DPH.IV / CBZ	TR
14	ILANGOVAN	46	M	844368	+	-	-	LF	-	Dysarthria	208	32	1.4	136	3.8	294	-	-	Right parietal infarct	-	Diabetic Left foot	I	DPH	TR
15	CHANDRAMOHAN	43	M	845452	+	-	3	LF	-	-	225	25	0.8	138	4.2	301	-	-	Normal	Abnormal Record	-	O	DPH	TR
16	MATHALAI MARY	61	F	847587	-	+	-	-	+	-	278	40	0.8	144	4.1	318	-	-	Right MCA infarct	-	-	I	DPH.IV / CBZ	PR
17	MUTHAMMAL	64	F	849113	+	-	-	RF	-	Altered sensorium	272	42	1.0	148	4.4	326.9	-	-	Left Subcortical infarct	-	-	I	DPH.IV / CBZ	TR
18	VEERASAMY	52	M	852148	-	+	3	-	+	Aphasia	258	24	0.8	146	4.7	319.6	-	-	Normal	-		O	DPH.IV / CBZ	PR
19	SUBRAMANI	48	M	853485	+	-	-	LF	-	-	232	35	1.1	146	5.0	321.8	-	-	Normal	-	Diabetic Right foot	I	DPZ	PR
20	GOVINDASAMY	58	M	854530	-	+	-	-	+	-	300	55	2.2	141	4.2	315.5	-	-	Normal	-	Hypertension	I	DPH.IV / GAR	TR
21	SAMBANDAM	72	M	855461	-	+	-	EPC	-	-	294	46	1.8	134	4.8	301.6	-	-	Normal	-	-	I	DPH.IV / CBZ	TR
22	VEERAIYAN	70	M	856142	+	-	-	LF	-	-	288	50	2.2	140	5.4	314	-	-	Normal	Abnormal Record	-	I	CBZ	TR
23	NADESAN	61	M	857021	-	+	2	LF		-	310	65	2.4	133	5.2	306	-	-	Normal	-	DM Nephropathy	I	DPH	TR
24	SUNDARAJAN	63	M	857701	-	+	-	LF	-	-	255	32	0.9	145	4.5	318.5	-	-	Normal	-	-	O	-	TR
25	RAJENDRAN	57	M	858423	-	+	3	RF	-	-	268	30	0.9	139	4.1	308	-	-	Left Subcortical infarct	-	-	I	DPH	PR

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26	GANESAN	52	M	859024	-	+	3		+	Altered sensorium	314	36	1.1	135	4.9	302.5	-	-	Normal	Post Ictal Dysfunction	CAHD	I	CBZ	PR
27	AMMENABEVI	52	F	861563	+	-	-	RF	-	-	326	40	1.2	135	4.1	302	-	-	Normal	-	-	I	DPH.IV / CBZ	PR
28	SAKTHIVEL	18	M	863359	+	-	-	RF	-	-	265	25	0.8	132	5.1	292.4	-	-	Normal	Abnormal Record	-	I	CBZ	TR
29	KRISHNAMMAL	70	F	863359	+	-	-	-	+	Altered sensorium	260	44	1.0	140	3.9	308.4	-	-	Normal	-	-	O	DPH	Died
30	BALASUBRAMANI	54	F	864625	+	-	2	LF	-	-	320	25	0.8	139	4.0	308.2	-	-	Normal	-	-	I	DPH. IV / CBZ	PR
31	VEERAMMAL	60	F	866748	-	+	3	-	+	Altered sensorium	326	60	2.6	145	5.4	328	+	+	Normal	-	Hypo thyroidism	I	DPH. IV / CBZ	PR
32	NAGAJOTHI	55	F	881979	+	-	3	LF	-	-	258	32	1.0	137	4.5	302.6	-	-	Normal	-	-	I	DPH. IV / CBZ	Died
33	BALUSAMY	52	M	870520	-	+	-	LF	-	-	296	44	1.2	140	4.5	312.7	-	-	Normal	-	-	I	DPH. IV / CBZ	TR
34	DURAISAMY	64	M	873941	-	+	-	RF	-	-	230	34	1.0	144	5.0	316.4	-	-	Normal	-	-	O	CBZ	TR
35	ANJAMMAL	57	F	874749	+	-	-	EPC	-	Altered sensorium	298	30	1.5	134	5.6	299.7	-	-	Normal		-	O	CBZ / GAR	TR
36	SAVITHRI	50	F	875926	+	-	-	LF	-	-	192	132	7.2	139	5.8	322.3	-	-	Normal	Abnormal Record	HT / Chronic Renal failure	I	CBZ	PR

No	Name	Age	Sex	Hospital number	Admission complaints			Seizure details			Blood sugar during seizures	Urea	Creatnine	Electrolytes		Osmolality	Acetone		CT scan brain report	EEG report	Other systemic problems	Treatment for DM I : Insulin O:OHA	Treatment for seizures DPH.IV, CBZ, SVP, GAR	Result TR: total recovery, PR: partial recovery, D: Died
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37	BASKARAN	48	M	877944	-	+	3	RF	-	-	262	26	1.2	140	4.0	306.8	-	-	Left Subcortial infarct	Abnormal Record	-	I	DPH.IV / CBZ	PR
38	RAMALINGAM	59	M	879545	-	+	2	-	+	-	271	32	1.0	138	4.2	304.7	-	-	Normal		-	I	CBZ	TR
39	PARVATHY	42	F	882352	-	+	-	LF	-	Altered sensorrium	241	88	3.9	137	5.1	312.2	-	-	-		DM / CRF	I	DPH.IV / CBZ	TR
40	PAKYIARAJ	56	M	882640	-	+	2	RF	-	-	324	28	1.4	141	3.8	311.8	-	-	Left Subcortial infarct		-	I	DPH.IV / CBZ	TR
41	MOHAMED ANSARI	65	M	883170	+	-	-	-	+	-	260	21	0.9	132	4.6	291.4	-	-	-		-	O	CBZ	TR
42	MUTHAYEE	60	F	889924	+	-	3	LF	-	-	315	168	8.5	139	6.1	335.7	-	-	Right Subcortial infarct		HT / Chronic Renal failure	I	DPH.IV / CBZ	PR
43	DAISYRANI	43	F	897326	-	+	-	-	+	Altered sensorium	308	98	3.1	141	4.8	325	-	-	Left Subcortial infarct	-	DM / CRF	I	DPH	TR
44	KALLIMUTHU	37	M	899572	+	-	2	RF	-	-	238	18	0.8	140	4.1	304.4	-	-	-		-	O	DPH / CBZ	TR
45	LOGAMMAL	57	F	900684	+	-	-	LF	-	-	216	21	0.7	136	3.8	294.5	-	-	-	-	Hypo thyroidism	O	CBZ	PR
46	NARAYANASAMY	62	M	902481	-	+	2	RF	-		254	25	1.0	135	4.0	296.2	-	-	Left Subcortial infarct	Abnormal Record	-	I	DPA	TR
47	KULANDAIRAJ	39	M	903705	-	+	3	RF			314	118	5.2	132	5.6	312.3	-	-	-		CRF	I	DPH.IV / CBZ	PR
48	ARUNACHALAM	61	M	905561	-	+	-	LF	-	-	248	34	1.5	134	4.7	297.8	-	-	-		-	I	DPH.IV / CBZ	PR
49	GOVINDASAMY	74	M	905674	-	+	-	-	+	Altered sensorium	330	28	1.2	142	4.2	315.2	-	-	Massive infarct (MCA/PCA)			I	DPH.IV / CBZ	Died
50	VELLAIAMMAL	45	F	905792	+	-	2	EPC	-	-	286	26	0.7	134	4.8	297.8	-	-	-	-	-	O	CBZ	TR